Industrial Degreasing Agents

3 Types of degreasing

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THE ideal solvent would be one that would degrease rapidly and efficiently in a small space and would be non-flammable, non-explosive, non-toxic, and non-irritating to the human skin. But the "ideal" solvent has never been attained. Therefore, when considering the substitution of one solvent for another, due to wartime restriction, shortages, or other reasons, this fact should be kept in mind. It then becomes necessary to select a cleaning agent on the basis of its effectiveness for the particular degreasing job required: its hazards, such as flammability, explosiveness, and toxicity; equipment needed; availability of supply, and cost.

Although there are many variations in degreasing, the principal methods of cleaning are: (1) use of alkaline compounds which exert a saponifying or emulsifying action on the grease or oil; (2) cleaning with chlorinated hydrocarbon solvents, and (3) use of petroleum solvents such as gasoline and naphtha. - mineral spirits

Alkaline Compounds

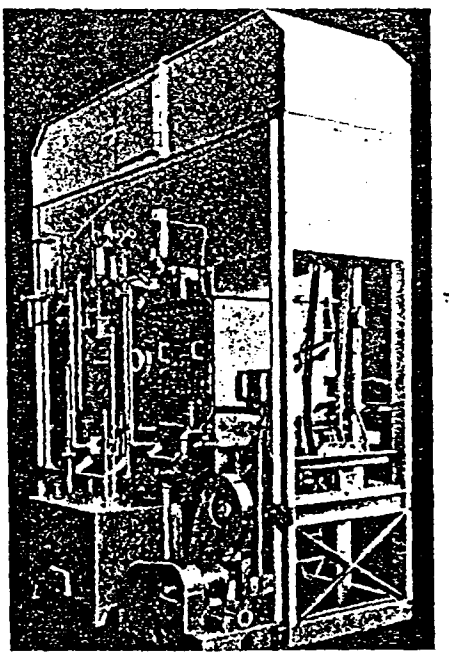
This method involves the use of cleaning agents such as sodium carbonate, caustic soda, tri-sodium phosphate, sodium sesquicarbonate, sodium silicate, and numerous commercial preparations which contain one or more of these substances. For some purposes, various mixtures of alkalis are used, such as sodium cyanide, tri-sodium phosphate, and soap chips, for cleaning copper or certain alloys containing copper.

Alkaline cleaning is effective for many metal parts, such as iron and steel castings. The alkali emulsifies oils and greases and the parts are dipped, tumbled, or sprayed often enough to wash them free of foreign matter. Alkaline cleaning is often used for cleaning sheet metal rolling from high speed mills.

Some of the shortcomings of alkaline cleaning are said to be the danger of etching precision parts and, if the washes are not thorough, the leaving of spots or streaks on the metal part. Moreover, alkaline cleaning may be slow and sometimes does not have the penetrating power to cleanse the less accessible corners of certain metal parts.

Chlorinated Solvents

Metal cleaning with chlorinated solvents is one of the latest developments in metal cleaning. This method has been in use for ten or twelve years in this country, although it was used extensively in Europe during the first World War. Its use is growing rapidly and, from the standpoint of effectiveness, it appears to be unequalled for cleaning metal parts, particularly die castings and those made of copper, brass, zinc, etc. In cleaning with chlorinated solvents, the outstanding advantages are rapidity of cleaning, volume cleaning in a small space, simplicity of operation, and suitability for cleaning on a mass production basis. Since the oil or grease is dissolved, no scum is left on the surface of the solvent and when the parts emerge from the degreaser they are dry and free of foreign material. As the equipment is economical of heat and space, this degreasing method is applicable to small as well as large industrial operations.



Vapor spray — Vapor degreaser

The principal chlorinated solvents used in degreasing are trichlorethylene, carbon tetrachloride, and perchlorethylene. All of these liquids are very effective in dissolving oils, greases, waxes, and fats used in machining and other manufacturing operations. The method is to either dip in the liquid, spray, or condense the vapors on the metal parts, or use combinations of these procedures.

There are some problems of corrosion in the use of chlorinated solvents. This subject was discussed by C. F. Dinley in *Metal Finishing*, August, 1942.

Pure trichlorethylene is susceptible to decomposition, liberating hydrochloric acid. This decomposition is stimulated by light, oxygen, and heat. All commercial trichlorethylene, therefore, contains a stabilizer to prevent such decomposition. Another stabilizer is added to commercial trichlorethylene to prevent decomposition induced by certain metals, notably aluminum, magnesium, zinc, and their alloys. The amounts of stabilizers added are small—a fraction of one per cent—and they have no perceptible effect on the physical and chemical action of the degreasing fluid.

In the case of carbon tetrachloride, corrosion may be reduced to a minimum by constructing the equipment of selected metals in the following order: nickel, Monel, 18-8 stainless steel containing 2-4% molybdenum.

lead, tin, well-tinned copper, galvanized iron, and copper.

Petroleum Solvents

Dry cleaning of metals by gasoline and other petroleum solvents met the small need for solvent cleaning in World War I. At present, an entirely new set of conditions is encountered in the fact that the existing war is one of mechanized equipment requiring more rapid metal cleaning on a vast scale.

In this type of cleaning, each part is dipped in successive baths and the cleaning agent easily becomes contaminated. The method is slow and not always efficient.

Fire and Explosion Hazards

There is no fire hazard in the use of the alkaline compounds. The chlorinated hydrocarbons, namely, carbon tetrachloride, trichlorethylene, and perchlorethylene are non-flammable, non-explosive, and non-combustible, although trichlorethylene-air mixtures are flammable under certain rather unusual conditions.

Gasoline, naphtha, and other low flash point solvents are, of course, highly flammable and explosive. Many companies, according to the National Safety Council, Industrial Data Sheet D-Gen. 13, do not permit their use for removing oil and grease because:

Properties	*Carbon Tetrachloride* (CCl_4)	*Trichlorethylene* ($CHCl:CCl_2$)	*Perchlorethylene* ($CCl_2:CCl_2$)
Boiling point °F.	170.15	188.8	249.8
°C.	76.75	87.1	121.0
Specific gravity (at 25°C.)	1.589	1.461	1.618
Lb. per gallon (at 25°C.)	13.22	12.16	13.46
Freezing point °F.	—23.0	—86.0	—22.4
°C.	—9.4	—122.0	—8.3
Flash point	None	None	None
Flammability	Non-flamm.	Non-flamm.	Non-flamm.
(Underwriters' Laboratories Rating)	Rated 0	Rated 1-2	Rated 0
Vapor density at boiling point sp. gr. (air = 1.00)	5.32	4.53	5.72
Viscosity, centipoises (at 25°C.)	0.88	0.56	0.84

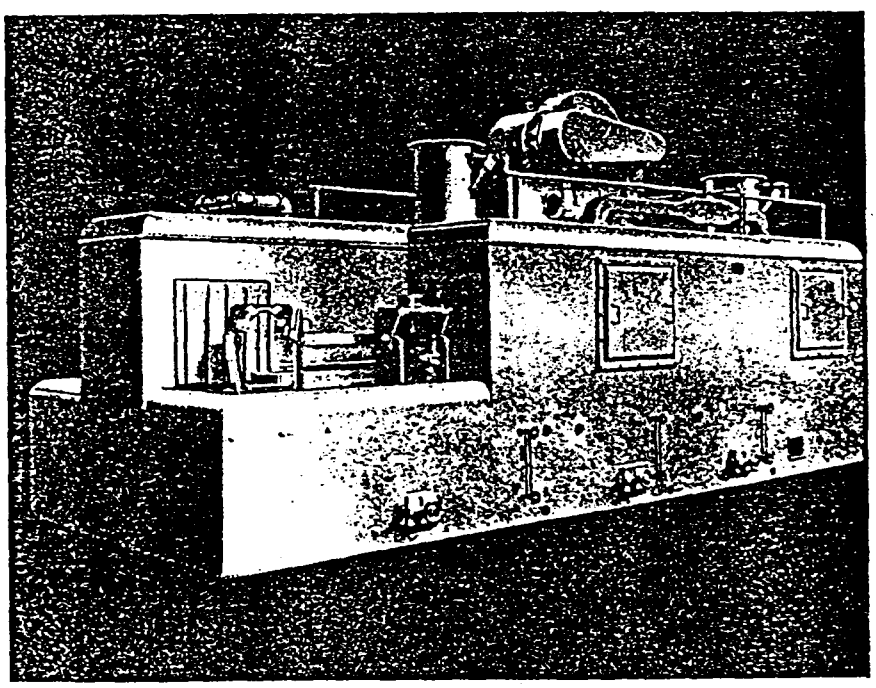
"(a) Such solvents vaporize readily and produce explosive mixtures with air, in some cases in proportion of about 1.4 per cent by volume, and

"(b) the vapors may be ignited by a spark or flame at temperatures considerably below zero Fahrenheit."

Consequently, high flash point petroleum solvents are used. The petroleum solvents may be classified from the fire risk standpoint in the following order: naphtha, gasoline, Stoddard's Solvent, and F-140, the most hazardous being named first.

Carbon tetrachloride is often added to flammable solvents to raise the flash-point and decrease the fire hazard. In this connection, the Carbon Tetrachloride Producers' Technical Committee states: " . . . Differences in rate of evaporation of carbon tetrachloride and the other solvents in the mixture may lead to the development of a flammable mixture during the course of evaporation of a blend which initially was non-flammable. Solvents such as naphtha differ so greatly in their flash points and boiling range that it is impossible to state in a general way the proportion of carbon tetrachloride that must be added to them to make them safe from fire and explosion hazard.

"Each solvent mixture must be formulated with the purpose for which it is to be used and with the chemical and physical characteristics of its various ingredients clearly in mind. Where the manufacturer of the mixture is uncertain on any of these points his safest course is to get the advice of someone with experience in the field."

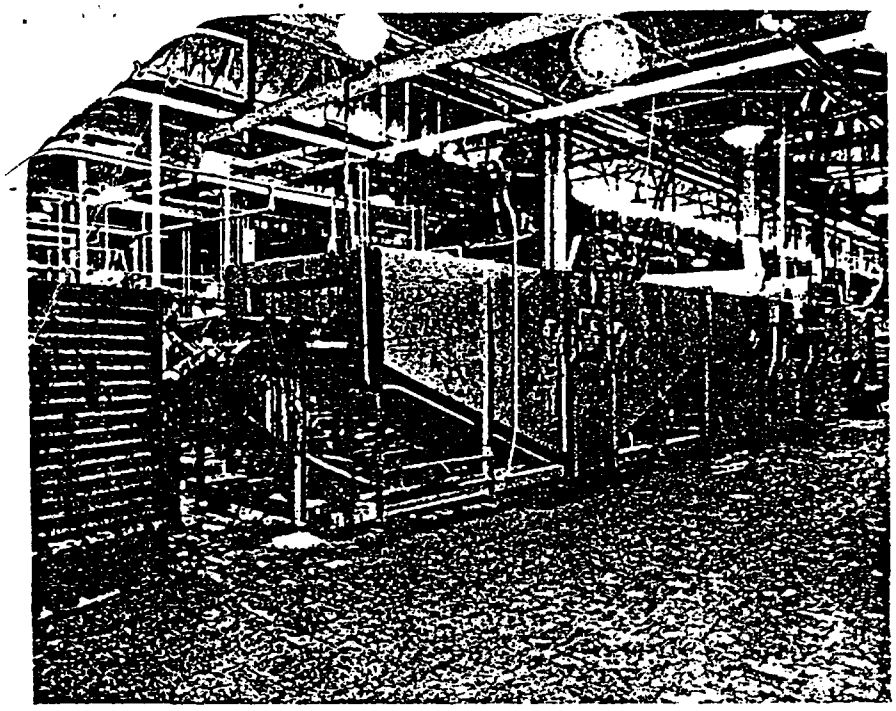


Emulsion or spirits cleaning machine.

Toxicity

Unfortunately, there are no solvents that are entirely without health hazards. The very qualities that make a good solvent appear also to embody a certain amount of hazard. This is true because every substance that dissolves fats will attack bodily organs unless it is used with care.

The chief hazard in connection with the use of alkalis is their action on the skin and clothes. Unlike many corrosive chemicals, sodium carbonate and caustic soda do not give warning of their presence by immediate burning and stinging. Hence, they may cause injury without the handler being immediately aware of it. Workers handling corrosive alkalis should



Five stage emulsion-alkali cleaning machine.

equipped with goggles, rubber gloves, rubber boots, and rubberized aprons.

The chlorinated solvents are all toxic, if their vapors are breathed in sufficient concentrations. Excessive amounts of chlorinated solvents in the atmosphere are indicated by their odor or by smarting sensations of the eyes and nose. Since their vapors are about five times as heavy as air, recommended ventilation of the workroom is of the down-draft type exhausting the vapors at floor level.

From a health standpoint the petroleum solvents are less hazardous than some of the other solvents. However, Dr. W. F. von Oettingen, Principal Industrial Toxicologist for the U. S. Public Health Service, points out that "the appraisal of hydrocarbons offers considerable difficulties because most of these solvents represent mixtures, sometimes of heterogeneous nature, and because their composition is often incompletely known. Certain solvents such as benzine, gasoline, and solvent naphtha may vary with regard to their chemical composition according to the source from which they are obtained and therefore may vary also with respect to their injurious action." Dr. von Oettingen suggests that chemical analysis be made in order to detect possible noxious components.

Just as they are classified from the fire risk standpoint, the petroleum solvents may be classified as to toxicity in the following order: naphtha, gasoline, Stoddard's Solvent, and F-140, the most toxic being named first.

Availability

In using all of these degreasing methods, concerns engaged in war work are, of course, assured of adequate supplies, while the supply is improving for other users. Caustic soda, for instance, is freely available.

With respect to the chlorinated solvents, the supply runs: carbon tetrachloride, trichlorethylene, and perchlorethylene, with the last two named having the same war-time restrictions and carbon tetrachloride being more plentiful. The supply of these three solvents has improved as the war has progressed. As of January 9, 1943, General Preference Order M-41 was amended to provide that users of carbon tetrachloride in classification B2 —which relates, among other uses, to degreasing machines especially designed to use such solvents at or near their boiling point—may receive 100 per cent of their monthly consumption during the twelve-month base period ending September 30, 1941. Relative to supplies of trichlorethylene and perchlorethylene, a recent War Production Board directive provides that a manufacturer of these solvents can sell to B2 users when the inventory of the solvent manufacturer is in excess of 500,000 pounds.

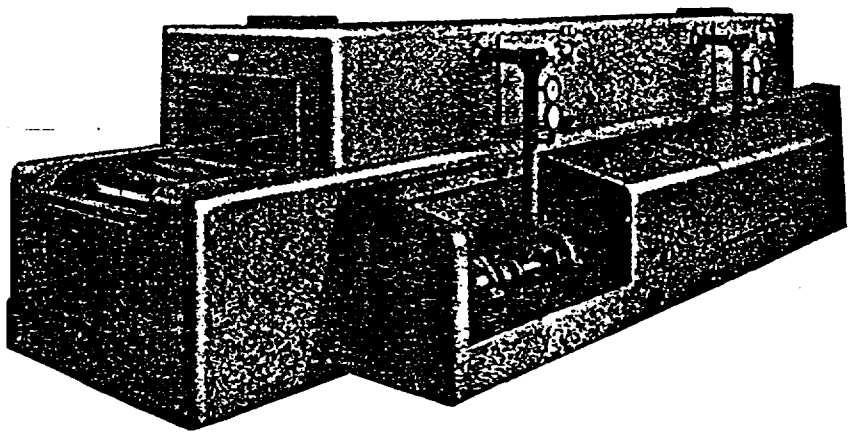
Improved solvent Use at end of WW II

At present, users of the petroleum solvents appear to have no difficulty in obtaining necessary supplies other than delay, in some sections, due to the transportation problem.

Costs

It is, of course, impossible to tell which method the individual operator can use at the lowest cost. On the whole, the alkaline compounds represent the lowest cost for supplies. In the case of the chlorinated solvents, the liquid is easily recovered and may be used over and over again, so that a higher original material cost may not always represent a higher operating cost.

(Illustrations courtesy of F. C. Mahon Co., Magnus Chemical Co., and Detroit Rex Products Co.)



Alkali cleaning machine.